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SITE AND STAND FACTORS INFLUENCING THE ABUNDANCE AND DISTRIBUTION OF CONIFEROUS ADVANCE GROWTH IN NORTHEASTERN ONTARIO

R.W. Arnup[1]

INTRODUCTION

Protecting advance growth by careful harvesting is attractive for a number of reasons. Costs related to seed and seedling production, site preparation, and tree planting are reduced or eliminated. The preservation of advance growth also retains the locally adapted gene pool on the site. The height growth of advance growth compares favorably with that of planted stock (Doucet and Boily 1986) and, since advance growth usually has an initial size advantage over planted or seeded trees, tending needs are reduced and the stand rotation period is shortened (Archibald and Arnup 1993).

To assist in forest-level planning, resource managers must be able to identify the location and extent of areas that have a high advance growth potential. Although the current natural regeneration techniques practiced in northeastern Ontario focus mainly on black spruce (*Picea mariana* [Mill.] B.S.P.), balsam fir (*Abies balsamea* [L.] Mill.) advance growth may provide an option to naturally regenerate some stands, should this species become more widely utilized.

The ecosite level of the Ecological Land Classification system for boreal Ontario occurs at approximately the same scale as does the forest inventory (1:20 000). In northeastern Ontario, these ecosites correspond to the Forest Ecosystem Classification (FEC) site types, which are defined as mappable, management-oriented groupings of vegetation that occur on a specific range of soil conditions (McCarthy et al. 1994). Because the site types integrate a number of stand and site factors, they provide a useful framework for understanding the distribution of advance growth across the forested landscape.

This note describes relationships between the abundance and distribution of black spruce and balsam fir advance growth, the site types for northeastern Ontario, and related stand and site characteristics. A predictive key is provided to assist managers in identifying stands with the potential for abundant black spruce advance growth.

STAND AND SITE FACTORS

The distribution and abundance of advance growth is related to: (i) stand factors, including tree species composition and canopy structure; and (ii) site factors, including the abundance of forest floor substrates that are suitable for layering and seeding, and the abundance of understory vegetation that inhibits layering or competes with established seedlings and layers. In the Clay Belt Section, black spruce advance growth abundance on peatlands was found to be related to site type, stand basal area, speckled alder (*Alnus rugosa* [Du Roi] Spreng.) cover, *Sphagnum* moss cover, and percent black spruce in the stand (Groot 1984). Walsh and Wickware (1991) reported similar relationships between black spruce advance growth distribution and stand and site factors, although they found that overall abundance levels of advance growth in north central Ontario were generally less than those reported for the Clay Belt.

A recent study in northeastern Ontario (Arnup 1996) found that both stocking and density of black spruce advance growth were related to stand age, total stand basal area, percent black spruce basal area in the stand, and percent *Sphagnum* moss cover on the forest floor (Table 1). In general, older, relatively pure black spruce stands with a

[1] Terrestrial ecologist and manager, Ecological Services For Planning Ltd., Timmins, Ontario P4N 2C6.

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low basal area, a high percent cover of *Sphagnum* moss on the forest floor, and growing on lowland site types had the highest stocking and density levels of black spruce advance growth. Upland stands that were dominated by black spruce, had high levels of *Sphagnum* moss cover, and a low total basal area showed medium stocking and density levels. Lowland stands with a high basal area, less than 90 percent black spruce, and less than 35 percent *Sphagnum* moss cover had low to medium stocking and density levels. Upland stands with less than 90 percent black spruce, a high total basal area, and low levels of *Sphagnum* moss cover had low stocking and density levels.

The distribution and abundance of balsam fir advance growth is also related to site conditions. In Quebec, balsam fir seedling densities were found to be highest on dry to mesic, balsam fir, herb, and moss site types growing on well to imperfectly drained tills (Côté and Bélanger 1991). Low seedling densities were associated with hardwood dominated stands, with abundant tall woody shrubs in the understory, and with an abundant deciduous leaf litter on the forest floor (Harvey and Bergeron 1989, Côté and Bélanger 1991).

A recent study in northeastern Ontario (Arnup 1996) found that stocking and density of balsam fir advance growth were significantly related to seedbed characteristics, stand structural elements, and soil moisture regime. In general, balsam fir advance growth levels were highest in older, open, coniferous or mixed upland stands with little moss cover and abundant woody debris on the forest floor. Advance growth levels were positively correlated to the amount of coniferous litter, woody debris, and logs on the forest floor, and to stand age. Advance growth was negatively correlated to the depth of organic matter, *Sphagnum* and feathermoss cover, cover of ericaceous shrubs, percent black spruce basal area, total stand density, and stand basal area. Fresh to moist soils had significantly higher levels of advance growth than did either dry or wet soils. Levels of balsam fir advance growth were not significantly related to either the stand content of hardwoods or to woody shrub cover, as might be expected due to competitive factors. However, only a limited range of these stand attributes was sampled.

SITE TYPE AND ADVANCE GROWTH RELATIONSHIPS

The mean percent stocking and density levels for black spruce and balsam fir advance growth by FEC site types are shown in Table 2. The highest mean stocking levels to black spruce advance growth were found in wet, nutrient-poor peatland sites (Site Types 11 and 14). Intermediate stocking levels were found in fresh to moist, herb-poor, black spruce dominated upland sites (Site Types 4, 5a, 5b, and 8); dry, herb-poor upland sites (Site Types 1, 2a, and 2b); moist to wet, herb-rich mixed coniferous sites (Site Types 9 and 13); and herb-poor black spruce–speckled alder sites (Site Type 12). Fresh to moist mixedwood or hardwood sites (Site Types 3b, 6a, 6b, 6c, 7a, 7b, and 10) had the lowest levels of stocking to black spruce advance

Table 1. Influence of stand age, total basal area, and proportion of black spruce basal area on black spruce advance growth stocking and density.

	Site Types 11,12,13 Lowlands		Site Types 4,5,8,9 Uplands	
	Stocking (%)	Density(stems/ha)	Stocking (%)	Density (stems/ha)
Stand age				
>120 years	72**	17 894***	51ns	10 584ns
<120 years	59	10 475	46	7 137
Total basal area				
>30 m^2/ha	81***	20 306***	56*	10 933*
<30 m^2/ha	45	6 925	40	5 853
Percent black spruce				
90–100 percent	73***	15 959***	54*	9 761**
50–89 percent	46	7 805	38	4 721
Sphagnum moss cover				
>35 percent	78***	19 277***	58*	10 354ns
0–34 percent	56	10 900	45	7 551

Significance levels for independent samples t-tests: *** = significant at p = 0.01;
** = significant at p = 0.05;
* = significant at p = 0.1;
ns = nonsignificant.

growth. Although the mean stocking level for Site Type 3a was intermediate, the sample size was small (four stands). A generalized relationship between black spruce advance growth stocking and the FEC site types is illustrated schematically in Figure 1.

The density of black spruce advance growth is more variable within site types, compared to stocking levels, probably because layered advance growth tends to occur in clumps. The mean density values for black spruce advance growth for site types with high stocking levels range from 15 000 to 20 000 stems per hectare. For site types with intermediate stocking levels, mean density values range from 5 000 to 15 000 stems per hectare. Mean densities were generally less than 5 000 stems per hectare for site types with the lowest stocking levels. In Site Types 7a and 7b, the mean density was less than 200 stems per hectare.

The distribution of balsam fir advance growth by site types appears to be the opposite of the distribution of black spruce advance growth. The highest mean stocking levels for balsam fir advance growth occur in herb-medium to herb-rich, mixed conifer stands with a high balsam fir component, on fresh to moist soils (Site Types 6b and 6c). Intermediate stocking levels were associated with fresh to moist mixedwood and hardwood sites (Site Types 3a, 3b, 6a, 7a, 9, and 10); fresh to moist, black spruce dominated upland sites (Site Types 4, 5a, and 8), and sites on very shallow soils (Site Type 1). Wet, black spruce dominated peatland sites (Site Types 11, 12, 13, and 14) and herb-poor, jack pine or black spruce dominated upland sites on dry to fresh, coarse soils (Site Types 2a, 2b, 5b) had the lowest stocking levels to balsam fir. The mean stocking level for Site Type 7b was low (28 percent), but the sample size was small (six stands). A generalized relationship between balsam fir mean stocking levels and FEC site types is illustrated schematically in Figure 2.

The mean density levels of balsam fir advance growth were somewhat lower than they were for black spruce. Site types associated with the highest balsam fir stocking levels had mean density levels ranging from 10 000 to 15 000 stems per hectare. Site types with intermediate stocking to balsam fir advance growth had mean density values from 5 000 to 10 000 stems per hectare, while site types with low stocking levels had mean density values of less than 5 000 stems per hectare.

MANAGEMENT APPLICATION–ADVANCE GROWTH PREDICTIVE KEY

FEC site types provide a useful framework for preharvest site inspections, and can be used as a predictive element because they integrate many factors that relate to advance growth abundance, including soil moisture regime, organic matter depth, stand composition, and seedbed characteristics (including cover levels for *Sphagnum* mosses and feathermosses). Other stand factors related to advance growth abundance, including stand basal area, stand age, and the percentage of black spruce in the stand, are features that cannot be interpreted from FEC information.

Table 2. Mean percent stocking and density for black spruce and balsam fir advance growth by northeastern FEC site types.

Site type	Name	Black spruce Stocking (%)	Black spruce Density (stems/ha)	Balsam fir Stocking (%)	Balsam fir Density (stems/ha)	Sample size
1	Very shallow soil	63	10 665	52	5 444	39
2a	Jack pine - coarse soil	54	8 764	19	1 021	14
2b	Jack pine - very coarse soil	58	16 135	11	1 808	15
3a	Mixedwood - medium soil	48	3 250	54	9 063	4
3b	Mixedwood - coarse soil	25	2 940	57	8 751	17
4	Jack pine- black spruce - coarse soil	60	8 446	41	3 410	46
5a	Black spruce - fine soil	61	7 926	43	6 332	21
5b	Black spruce - medium soil	57	5 244	30	3 439	9
6a	Mixedwood - fine soil	26	1 873	51	8 723	30
6b	Conifer mixedwood - medium soil	19	875	78	12 977	11
6c	Hardwood mixedwood - coarse soil	18	857	86	12 536	7
7a	Hardwood - fine soil	4	68	59	7 753	22
7b	Hardwood - medium soil	5	104	28	4 292	6
8	Black spruce - feathermoss - *Sphagnum*	61	11 053	45	6 375	68
9	Conifer - moist soil	40	5 396	57	7 576	65
10	Hardwood - moist soil	21	2 036	47	6 566	29
11	Black spruce - Labrador tea	76	16 372	17	2 135	107
12	Black spruce - speckled alder	65	12 473	26	3 240	66
13	Conifer - speckled alder	45	6 585	36	4 078	64
14	Black spruce - leatherleaf	91	24 931	3	145	16

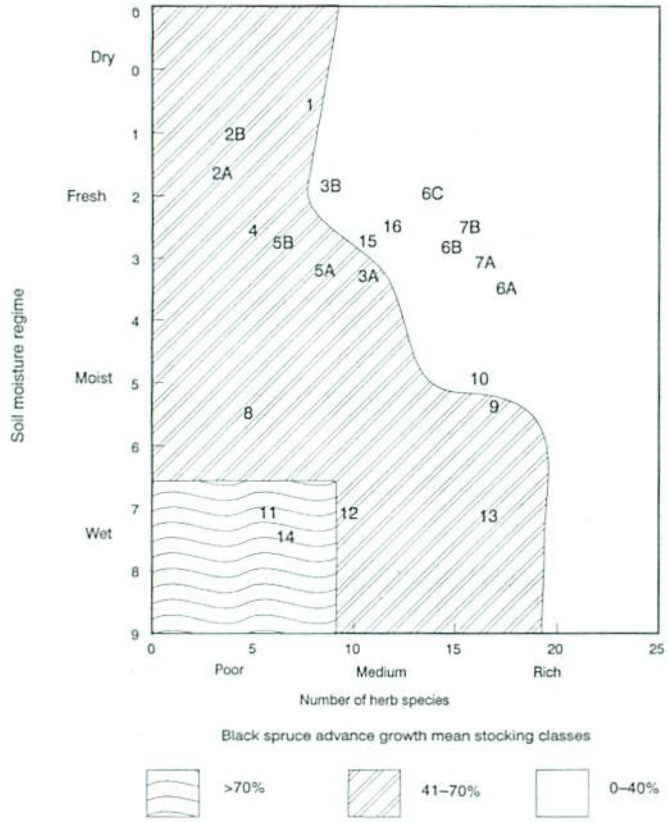

Figure 1. Diagram showing the general relationship between black spruce advance growth stocking and the northeastern FEC site types.

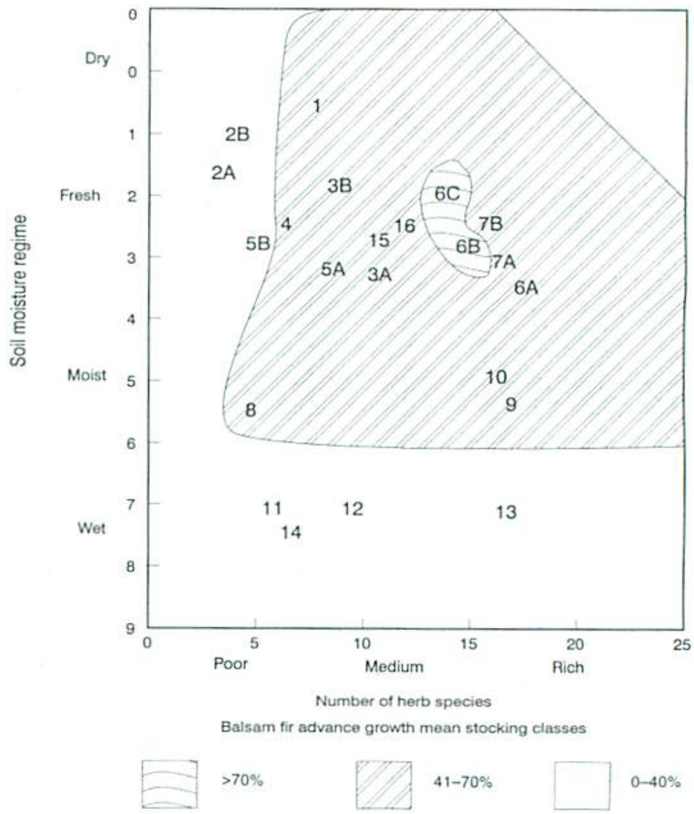

Figure 2. Diagram showing the general relationship between balsam fir advance growth stocking and the northeastern FEC site types.

However, they are described by the Ontario Forest Resource Inventory (FRI).

FEC information can be used in conjunction with FRI stand information to identify stands that have a high potential for black spruce advance growth. A simple key that uses FEC site types and stand factors which can be related to the FRI to predict the potential for black spruce advance growth was prepared (Fig. 3). Three classes of black spruce advance growth potential were identified:

1. **High** — stands with 70 percent or greater stocking to advance growth, typically with advance growth density levels that range from 10 000 to 20 000 stems/ha;

2. **Medium** — stands with 40 to 69 percent stocking to advance growth, typically with advance growth density levels that range from 5 000 to 10 000 stems/ha; and

3. **Low** — stands with less than 40 percent stocking, typically with advance growth density levels less than 5 000 stems/ha.

This key should be used with forest-level planning applications. Since there is considerable variation in advance growth stocking levels within site types, predicting advance growth potential for individual stands should be done with caution. Field inspections should be carried out and recent aerial photographs examined to confirm stand attributes and advance growth stocking levels for individual stands.

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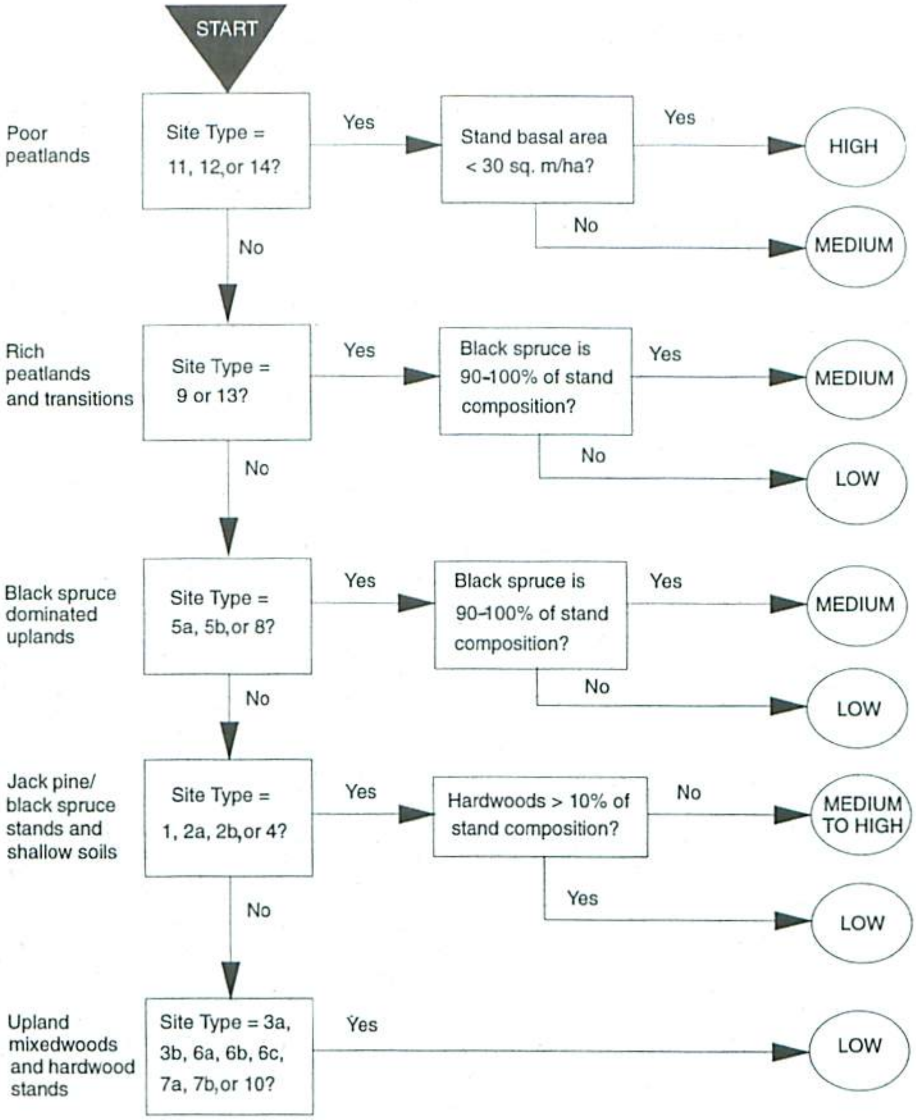

Figure 3. Forest-level key to determine the potential for black spruce advance growth using FEC site types and stand information.

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